

REMARKS

A. INTRODUCTORY REMARKS

Applicant has revised the specification on page 1, line 21, and amended claims 6, 15, and 20. Support for the amendments may be found in the literature, and in the specification (page 10, lines 8 and 9) and example (ionic conductivity measured at conventional operating temperatures for solid polymer electrolyte fuel cells within the range of room temperature to 200°C). No new matter is presented by these amendments. Accordingly, applicant respectfully requests entry thereof and reconsideration of claims 1-23 in light of the following remarks.

Claims 1-23 are pending in this application. Claims 6, 15, 20 and 22 were rejected under 35 U.S.C. §112, second paragraph. Claims 1-3, 6-12 and 15-23 were rejected under 35 U.S.C. §102(b) as anticipated by Bahar *et al.* Claims 1, 2, 5-11 and 14-23 were rejected under 35 U.S.C. §102(b) as anticipated by Grot *et al.* Claims 1-4, 8, 10-13, 17 and 19 were rejected under 35 U.S.C. §103(a) as being unpatentable over Watanabe *et al.*, in view of Grot *et al.* Applicant respectfully submits that all of the pending claims are allowable for the reasons that follow.

B. OBJECTIONS TO SPECIFICATION

On page 2 of the Office Action, the Examiner objected to informalities in the specification concerning the disclosure on page 1, lines 20-21, that recites "a solid polymer electrolyte (SPE) fuel cell operable at a temperature of 600-1000 °C". The Examiner indicated that SPE fuel cells did not operate at these high temperature ranges citing the book, *Fuel Cells and their Applications* (1996), authored by Kordesch *et al.* See, Office Action, page 2.

Applicant appreciates the Examiner's pointing out this informality. The Examiner was correct in noting that the temperature range was a typographical error. Accordingly, applicant has corrected this typographical error to recite a range of room temperature to 200 °C for a Polymer Electrolyte Fuel Cell (PEFC) as disclosed on table 4-1 of the above referenced book.

C. REJECTION UNDER 35 U.S.C. § 112

Claims 6, 15, 20 and 22 were rejected under 35 U.S.C. 112 second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Specifically, it was stated that claims 6, 15 and 20 each recite "at least about 30 %", which the Action alleged was indefinite. Office Action, page 3.

Applicant appreciates the suggestions of the Examiner on pages 2 and 3 of the Office Action and believes that the claims as amended are patentable. Applicant has amended the claims to recite a porosity of about 30% or greater, as described in the specification, *inter alia*, at page 10, lines 8 and 9. The amendments to the claims do not further limit the claims, but rather clarify them to recite what was originally claimed. Applicant respectfully requests that the Examiner reconsider and withdraw this rejection.

D. REJECTION UNDER 35 U.S.C. § 102 (b)

On pages 3-5 of the Action, claims 1-3, 6-12 and 15-23 were rejected under 35 U.S.C. § 102 (b) as being anticipated by Bahar *et al.*, U.S. Patent No. 5,635,041 ("Bahar"). The Action asserts that "[r]egarding claims 1-3, Bahar teaches a composite membrane comprising a base material 4 and an ion exchange material/resin 2. The base material is a porous microstructure (porous support) and the ion exchange resin impregnates the membrane, *i.e.* base material (col. 3, lines 29-40)." *See*, Action at page 3. The Action further alleged that the ion exchange materials may optionally be complemented by finely divided powders or other (non-ionic) polymers to provide final composites, and that such a finely divided powder may be selected from organic or inorganic compounds such as, but not limited to, carbon black, graphite, nickel, silica (SiO₂), titanium dioxide (TiO₂) or platinum black (catalyst). It was further asserted that the powders provide specific added effects such as electrical conductivity, thermal conductivity, catalytic effects and/or enhanced or reduced reactant transport properties, citing col. 4, line 66 to col. 5, line 8 of Bahar. Finally, the Action noted that "silica and titanium dioxide were moisture retentive materials and platinum was a catalyst as described in the instant specification (page 9, lines 9-21)." Action, at page 4.

Applicant respectfully traverses this rejection. Applicant submits that Bahar discloses a composite membrane comprising a base material such as a polytetrafluoroethylene membrane having a porous microstructure of polymeric fibrils wherein an ion exchange

material is embedded into the porous membrane. See, col. 3, lines 29-30. Applicant also submits that Bahar discloses that the ion exchange material may also be comprised of at least in part a powder, such as but not limited to, carbon black, graphite, nickel, silica, titanium dioxide, and platinum black. See col. 2, lines 58-61. Applicant notes that Bahar discloses that the finely divided powders or other non ionic polymers used to provide final composites provide added effects such as different aesthetic appearance (color), electrical conductivity, thermal conductivity, catalytic effects or enhanced or reduced reactant transport properties. See, col. 5 line 2-8. Bahar fails to disclose a reinforced composite ionic conductive polymer membrane as recited in the present claims.

Applicant's invention as recited in claim 1 is directed to a reinforced composite ionic conductive polymer membrane which has improved ionic conductivity, improved moisture retention, and reduced cross over of liquid fuel by the addition of a reinforcing agent that in turn improves the overall efficiency of the fuel cell. Applicant's reinforced composite ionic conductive polymer membrane comprises: a porous support; an ion exchange polymer that impregnates the porous support; and a reinforcing agent that impregnates the porous support. The reinforcing agent is at least one selected from the group consisting of a moisture retentive material and a catalyst for facilitating oxidation of hydrogen. Bahar fails to disclose a separate reinforcing agent.

Even if Bahar discloses that the ion exchange polymer is embedded into a porous support base such as polytetrafluoroethylene, Bahar fails to specifically teach the addition of a "reinforcing agent" that is separate from the ion-exchange polymer. Rather, Bahar discloses powders and other complementary materials that are incorporated into the ion-exchange polymer. Because these materials are incorporated into the ion-exchange polymer, they are not believed to be available as a reactant to reinforce the membrane and provide moisture-retentive effects. Thus, Bahar does not disclose or suggest a separate reinforcing agent selected from the group consisting of a moisture retentive material and a catalyst for facilitating oxidation of hydrogen in addition to the ion-exchange polymer. Bahar therefore fails to disclose all of the features recited by the presently claimed invention, and accordingly, claim 1 and its dependent claims are allowable over Bahar.

On pages 5 and 6 of the Action, claims 1, 2, 5-11 and 14-23 were rejected under 35 U.S.C. § 102 (b) as being anticipated by Grot *et al.*, U.S. Patent No. 5,919,583 ("Grot"). The Action alleges that regarding claims 1, 2, 6, 7, 10, 11, 15, 16, 19 and 21, "Grot teaches a cation exchange membrane made from a polymer having cation exchange groups and

containing inorganic filler.” Action, at page 5. the Action also alleged that “the inorganic filler is an inorganic proton conductor selected from the group consisting of titanium dioxide, tin and hydrogen mordenite, oxides and phosphates or zirconium, and mixtures thereof.” *Id.* The Action further noted that “titanium dioxide, zirconium oxide, mordenite and zeolite are moisture retentive materials, as described in the instant specification (page 9, lines 9-21). *Id.*

Applicant respectfully traverses this rejection. Grot discloses cation exchange polymer membranes having cation exchange groups and inorganic fillers dispersed therein that exhibit reduced fuel crossover. The inorganic filler groups are selected from a group consisting of titanium dioxide, tin and hydrogen mordenite, oxides and phosphates of zirconium, and mixtures thereof. Like Bahar, Grot fails to disclose the use of a reinforcing agent that is separate from the ion-exchange polymer. Rather, these documents merely describe conventional fillers and additives incorporated into polymers. Incorporating these fillers and additives into the ion-exchange polymer is not the same as adding a reinforcing agent as a separate component of the composite ionic conductive polymer membrane. Accordingly, Grot does not disclose all of the features recited in the present claims. Applicant respectfully requests that the Examiner reconsider and withdraw this rejection.

Dependent claims 2, and 5-9 that directly depend from claim 1 also are allowable. In a similar fashion, claims 10, 11, and 14-23 should all be held allowable as the polymer composite is novel and its use should also be allowable in a hydrogen and a direct methanol fuel cell.

E. REJECTION UNDER 35 U.S.C. § 103

On pages 6-8 of the Action, claims 1-4, 8, 10-13, 17 and 19 were rejected under 35 U.S.C. §103 (a) as being unpatentable over Watanabe *et al.*, US Patent No. 5,766, 787 (Watanabe) in view of Grot. The Action alleges that “Watanabe teaches a solid polymer electrolyte fuel cell comprising a solid polymer electrolyte membrane incorporating 5.8% platinum catalyst and 5 wt% silica in Nafion (perfluorocarbon sulfonic acid cation exchange resin) or 5.8 wt% platinum catalyst and 5 wt% titania (TiO₂) in Nafion.” Action, at page 7. The Action alleged that “the platinum catalyst is about 54 wt% and the silica (or titania) is about 46 wt % of the total amount of catalyst plus metal oxide (reinforcing agent) contained in the polymer electrolyte membrane.” *Id.* The Action alleged further that the “membrane comprises 0.01-80 wt% of at least one metal catalyst (Pt, Au, Pd, Rh, Ir and/or Ru) and 0.01-

50 wt% of particles and/or fibers of at least one metal oxide (silica, titania and/or zirconia).
Id.

The Action recognized that Watanabe does not explicitly state that the polymer electrolyte membrane includes a porous support, but alleged that Grot teaches a cation exchange membrane made from a polymer having cation exchange groups and containing inorganic filler. Based on these combined teachings, the Action concluded that "the invention as a whole would have been obvious to one having ordinary skill in the art at the time the invention was made because one of skill would have been motivated to incorporate a porous support in the polymer electrolyte membrane of Watanabe in order to improve the mechanical properties and/or decrease the cost of the membrane." Action, at page 8.

Applicant respectfully traverses this rejection. Even if the documents were combined as alleged in the Action, the combination still would not result in the presently claimed invention. Rather, all that would result would be an ion-exchange polymer containing conventional additives and fillers, and a porous support. No additional reinforcing agent is disclosed or suggested by the cited art. Indeed, the prior art cited in the Action teaches directly away from adding the reinforcing agent as a separate component by disclosing the addition of certain fillers and additives into the ion-exchange polymer. As stated above, incorporating additives and fillers into an ion-exchange polymer is not the same as adding a separate reinforcing agent that impregnates the porous support, as recited in the present claims. The combination of Watanabe and Grot therefore fail to render obvious the present claims. Applicant respectfully requests that the Examiner reconsider and withdraw this rejection.

In view of the response submitted herewith, applicant respectfully submits that claims 1-23 are in condition for allowance, an indication of which is solicited. In the event that any issues remain outstanding, applicant would appreciate the courtesy of a telephone call to the undersigned counsel to resolve such issues in an expeditious manner and place the application in condition for allowance.

If fee payment is enclosed, this amount is believed to be correct. However, in the event that any additional fees are necessary, the Commissioner is hereby authorized to charge our Deposit Account No. 50-1645.

Respectfully submitted,

LEE & STERBA, P.C.

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PETITION and
DEPOSIT ACCOUNT CHARGE AUTHORIZATION

This document and any concurrently filed papers are believed to be timely. Should any extension of the term be required, applicant hereby petitions the Director for such extension and requests that any applicable petition fee be charged to Deposit Account No. 50-1645.

If fee payment is enclosed, this amount is believed to be correct. However, the Director is hereby authorized to charge any deficiency or credit any overpayment to Deposit Account No. 50-1645.

Any additional fee(s) necessary to effect the proper and timely filing of the accompanying-papers may also be charged to Deposit Account No. 50-1645.